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## SHOE MODIFICATIONS IN LOWER-EXTREMITY ORTHOTICS

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### INTRODUCTION

The art and science of correcting foot deformities is still a mixture of tradition, artisan skill, clinical experience, and the prescribing doctor's professional convictions. Although it is the orthotist's duty to discuss with the orthopedist any questionable aspects of a prescription, it is obviously not his privilege to countermand the doctor's judgment in the matter.

It must also be understood that a foot deformity is not to be taken as an unalterable fact until all methods of relief, such as physiotherapy and surgery, have been fully explored. The orthotist must also appreciate the fact that the basic principles of foot correction have yet to be agreed upon by anatomists or orthopedists. Some specialists even dispute the location of the arches. In spite of controversy, however, the orthotist must properly implement the prescription as given him by the orthopedic surgeon, otherwise, his knowledge of shoe modifications will be of little value to the patient.

Not included in this presentation are the foot problems of the infant, the adolescent, and adult females. Based upon an intra-VA lecture, the material presented here quite naturally applies primarily to the adult male.

### PURPOSE OF SHOES AND MODIFICATIONS

Originally shoes were a simple covering used to protect the foot from sharp stones and thorns and from the uncomfortable vagaries of the weather. As with other forms of body covering, it was not long before footwear became embellished with decorative effects and acquired a function in overall cosmesis and social accept-

ability. In terms of locomotion, however, the shoe is basically a means of weight transfer to the ground. Today's shoe, with its relatively light upper part, a stiff or thick sole and heel, and an almost flat insole and outsole, provides the normal foot with adequate support and purchase upon the ground.

With proper modifications, shoes can also be made to afford the deformed foot protection, cosmesis, and better balance for standing and walking. Indeed, the main purpose of all shoe modifications is the restoration of as normal a gait and weight-bearing pattern as is possible for the patient.

Shoe modifications are even more important when fitting the person who must wear a leg brace. A brace can be made to fit the patient beautifully and to function perfectly, but its effectiveness will be lost if the orthotist has overlooked the correct construction of the shoe or the factors necessary for functional weight-bearing. With a poor shoe foundation, the brace cannot be held in true alignment, and a leaning-tower-of-Pisa effect will result from the tendency of the foot and leg to tilt the brace in the direction favored by the residual pathology.

By redistributing body weight away from the sensitive areas of the foot to the nontender parts, the orthotist strives not only to relieve his patient of pain but also to achieve a well balanced weight-bearing pattern for him.

Ideally, weight bearing is distributed over the sole in a three-point pattern, i.e., upon the apex of the plantar surface of the calcaneus, upon the first metatarsal head, and upon

the fifth metatarsal head (Fig. 1). For most of his orthopedic patients, however, the orthotist must resort to the judicious use of shoe modifications to achieve a three-point pressure pattern on the sole of the foot.

The location, shape, and size of the modifications can be determined by temporarily taping or gluing components to an unmodified stock shoe. Observation of the gait pattern and examination of the shoe bottom for proper tread will indicate to the orthotist the need for any further changes. If extensive changes are necessary, orthopedic shoes should be recommended. Our concern here, however, is mainly with modifications that can be made with stock shoes that are available at almost any store.

### SHOE CHECKOUT

Before applying any modifications, however, the orthotist should first check out the stock shoe (Fig. 2).

The stock shoe should afford ample width from the metatarsophalangeal joints anteriorly to the ends of the distal phalanges to allow the greatest amount of toe prehension possible at pushoff. A comfortable but snug fit from the waist of the shoe to its heel is necessary for support and to prevent motion at the quarters during dorsiflexion. The straight inner border, or as it is sometimes referred to, the straight inner-line combination last, affords these desired features.

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## FIFTY YEARS AFTER ZAMOSKY'S ARTICLE "SHOE MODIFICATIONS IN LOWER-EXTREMITY ORTHOTICS"

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**T**he art and science of correcting foot deformities is still a mixture of tradition, artisan skill, clinical experience, and the prescribing doctor's professional convictions [1]. Zamosky's 1964 article on various shoe modifications in lower-extremity orthotics starts with this observation [1]. Reflecting on 50 years of development in this field, we ask ourselves, Have the ingredients of this mixture changed?

Computer-aided design and computer aided manufacturing [2] have changed the elements of the ingredient "artisan skill." However, creating a last from which shoe modifications are fabricated remains an artisan skill, as reflected by the ongoing debate over the relatively low intra- and intercaster reliability [3–4]. The implicit knowledge of the artisan skill still seems to be too complicated to translate into an explicit computer-aided skill. Other technological advancements involve new objective measurement systems. In-shoe pressure measurement systems show promise for analyzing the effect of shoe modifications on plantar pressure distribution [5]. Advanced gait analysis systems provide the option to analyze gait performance before and after shoe modifications [6]. "Objective measurement" is a new ingredient in the mixture.

"Patient perspective" is another ingredient that can be added to Zamosky's mixture. Even when a shoe is "perfectly" modified, it is only effective if worn. As such, patients have an increased role in their own care compared with 50 years ago. This is reflected in studies with patient-reported outcomes as a primary outcome measure [7–8], together with a shift in clinical practice from a product-oriented toward a patient-

oriented method of prescribing and providing shoes.

The remaining ingredients—"tradition," "clinical experience," and "prescribing doctor's professional convictions"—are preferably balanced by reference to evidence-based guidelines. Although national protocols [9] or disorder-specific algorithms [10] can be found, an international guideline for prescribing and providing shoe modifications is an important gap in the literature. To progress from tradition and clinical experience, evidence-based guidelines need to be developed.

Fifty years after Zamosky's article, the ingredients of his mixture for prescribing and providing shoe modifications have changed in-line with advancing technology and changes in patients' role in their own care. The evidence base in this field will continue to profit from the addition of objective measurements and patient-reported outcomes, yet the lack of international guidelines is a reason for concern.

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